

## **MIFACE Investigation Report: #13MI009**

### **Subject: Assistant Manager at Fertilizer Mixing Facility Dies When Pinned Under Overturned 1972 Tractor Without a ROPS**

#### **Subject**

In the winter of 2013, a male fertilizer mixing facility assistant manager in his 30s died when his 1972 Case 580B Construction King tractor with a front end loader overturned after sliding down the walls of a drainage ditch. The tractor was not equipped with a roll over protection structure (ROPS) and seat belt. The decedent had unsuccessfully attempted to remove a 12-foot section of the rail of a railroad on the south side of the facility with the tractor bucket. The facility's General Manager determined that another method should be used to remove the rail. The decedent was in the process of backing the tractor away so he could move it to another area. The tractor length, including the bucket was approximately 15 feet. The decedent backed the tractor approximately 20 feet. The ground was snow covered. The back wheels of the tractor slipped into an approximate nine-foot-deep ravine with an unmarked edge. As the tractor was sliding down the ditch, he attempted to drive the tractor forward, but the tractor continued to slide into the ravine. When the front wheels of the tractor reached the edge of the ravine, the tractor overturned to the rear. The decedent was pinned against the ravine bank by the tractor seat. A ROPS was an optional piece of equipment when the tractor was built in 1972.



Figure 1. Tractor overturned in ditch

Factors that contributed to this incident include:

- Tractor not equipped with a ROPS and seatbelt
- Edge of embankment not marked
- Frozen, snow-covered ground
- Two-wheel drive tractor was not equipped with chains for traction

## **RECOMMENDATIONS**

- Retrofit older tractors with properly designed and manufactured ROPS and seat belt. If a ROPS is not available, consider replacing the older tractor with a tractor which can be equipped with or already has a ROPS.
- To alert workers, mark edges of an embankment with visual cues, such as elevated, reflective stakes, orange fencing, or permanent barriers when in a traveled work area to alert workers.
- Tractor operators should use extreme caution when using tractors on or near sloped terrain, ditches, or embankments.
- Management should develop and implement a written safety and health program and train employees about the program.
- Install tire chains on two-wheel drive tractors during winter to aid traction.

## **BACKGROUND**

In the winter of 2013, a male fertilizer mixing facility laborer/assistant manager in his 30s died when his 1972 Case 580B Construction King tractor with a front end loader overturned after sliding down a ravine. The tractor was not equipped with a ROPS and seat belt. MIFACE researchers learned about this incident from the MIOSHA 24-hour ASAP report. The researchers contacted the decedent's employer, who agreed to participate with the MIFACE program. In the summer of 2013, the MIFACE researcher met with the office manager. The office manager accompanied the MIFACE researcher to the incident scene and permitted the researcher to take incident scene pictures. During the writing of this report, the death certificate, police and medical examiner reports and the MIOSHA compliance officer file were reviewed. The pictures used in Figures 1-4 are courtesy of the responding police. The pictures in Figures 5 - 6 were taken at the time of the MIFACE site visit. Pictures which included identifiers have been altered to remove the identifier.

The employer blended and sold fertilizer and field beans. On average, six non-unionized individuals worked on a full-time basis; during the winter, the employment number declined to five individuals due to workload. Work hours fluctuate with the seasons; longer during busy seasons (spring – fall) and a more standard 8:00 a.m – 5:00 p.m. in the winter. The decedent had been employed with the firm for 17 years as a “laborer”. For the past nine years, when the manager was not on the site, he assumed the role of the Assistant Manager.

The decedent was primarily responsible for grinding, blending, and delivering feed and blending fertilizer. The decedent operated the Case 580B tractor primarily in the summer in an area of the facility away from the incident site. The decedent had received on-the-job training on this equipment. He was shown how to operate it and was required to demonstrate competence in its operation. Although he was familiar with most of the facility grounds, he had not previously operated the tractor at the incident site.

The employer did not have a written health and safety program nor did they have a formal safety training program. The General Manager and employees normally discussed the day's work to be performed, maintenance which needed to be performed, and any miscellaneous safety issues over coffee in the morning. On-the-job employee training was provided by the employer and equipment dealers. The employer provided limited classroom-style training. Training documentation was not maintained. The employer had operator's manuals for each piece of equipment involved in the incident.

#### *Employer remediation after the incident*

The employer installed orange plastic fencing at the edge of the ditch to define the edge location (Figure 3).

MIOSHA General Industry Safety and Health Division issued the following alleged Serious citation at the conclusion of its investigation.

- Tractors, Part 22, Rule 2217(1)): Provide a roll-over protective structure on a tractor operated on a slope:

(No roll-over protection structure when operating tractor on a slope, 508 B Case Tractor Construction King 1972 – South Side of Facility).

## **INVESTIGATION**

The equipment involved in the incident was a 1972 Case Construction King 580B tractor equipped with a front end loader bucket. ROPS and seat belt were not standard items on tractors sold in 1972, they were offered as optional pieces of equipment. The tractor had a shuttle shift, hydrostatic transmission. The length of the tractor and bucket was approximately 15 feet. Although not a factor in this incident, the MIOSHA compliance officer noted that the alternator fan was not appropriately guarded. The office manager indicated that the tractor did not have any operational issues.



Figure 2. Identification (yellow arrow) and location of railroad spur being removed

A non-utilized railroad spur was located between two buildings, making it difficult to access an entrance to a feed building. The employer determined that 12 feet of the spur should be removed for building access, and as a precursor to a remodeling project that was scheduled for the spring.

The General Manager of the facility had previously attempted to remove a 12-foot rail section with the Case 580B without success due to the frozen ground conditions.

On the day of the incident, the General Manager assigned the decedent two job tasks; one of the two tasks was to remove

the same rail mentioned above. The decedent chose as his first task to remove the rail. He drove the tractor to the site. The General Manager and the decedent attached a chain to the bucket and attempted to again remove the rail by raising the bucket. The decedent was unsuccessful in raising the 12-foot rail section. The General Manager told the decedent to stop as they would try another method to remove the rail, and to drive the tractor to another location on the facility grounds. The General Manager then turned away from the tractor to take a phone call as the decedent backed the tractor away from the end of the spur.

Approximately 20 feet from the end of the railroad spur was an approximately nine-foot-deep drainage ditch. The ground sloped gently from the spur to the edge of the ditch, which was unmarked. The ground was frozen and lightly covered with snow (Figure 3).

As the decedent backed the tractor, he apparently misjudged where the edge of the ditch was located. The tractor's rear wheels went over the edge and the tractor began to slide into the ditch (Figures 1 and 4). It is postulated that the decedent attempted to drive the tractor out of the ditch; responding



Figure 3. Overview of incident site after incident. Note orange fence installed by employer at embankment edge.



Figure 4. Final resting position of tractor. Note embankment slope.



police found the tractor transmission in forward. The tractor continued to slide into the ditch. When the front wheels of the tractor reached the edge of the ditch, the tractor overturned to the side. The decedent was pinned against the ditch bank by the tractor seat.

A customer came in to the office and told the office manager to call 911. The decedent's coworkers drove another piece of equipment, a Wrangler (New Holland 18LA TC55D), which was normally used to unload pallets of food or load fertilizer was driven to the incident scene. Using a chain attached to the Wrangler and tractor, coworkers and responding police lifted the overturned tractor to free the decedent. Once the decedent was moved from under the tractor, emergency responders initiated first aid measures. The decedent was declared dead at the scene.

### **CAUSE OF DEATH**

The cause of death as listed on the death certificate was respiratory arrest due to a crushing injury to his chest. Toxicological findings were negative for alcohol, illegal or prescription medications.

### **RECOMMENDATIONS/DISCUSSION**

- Retrofit older tractors with properly designed and manufactured ROPS and seat belt. If a ROPS is not available, consider replacing the older tractor with a tractor which can be equipped with or already has a ROPS.

The tractor involved in this incident, manufactured in 1972, was not equipped with ROPS or a seatbelt, which protect the operator in the event of a rollover. ROPS first became available as optional equipment on farm tractors in 1971, but were not required to be installed by tractor manufacturers until October 25, 1976, when OSHA Standard 29 CFR 1928.51 went into effect. Older tractors can be equipped with a ROPS and seatbelt. There are two basic types of ROPS for farm tractors: protective frames (two- or four- post structures attached to the tractor chassis) and protective enclosures (cabs or enclosures built around a protective frame). ROPS are designed to help limit a tractor overturn to 90 degrees and to provide the operator a "zone of protection". The operator must stay within this zone.

The operator will not be protected by the ROPS during an overturn if the operator is not wearing a seatbelt. Without a seatbelt, the operator may be totally or partially thrown off the tractor. The seatbelt keeps the operator within the "zone of protection" provided by the ROPS. Even inside a cab, seat belts are important to keep the operator from being thrown against the frame, through a window, or out a door. *Seat belts should not be used on tractors that do not have ROPS.*

There are several internet websites that list ROPS suppliers, models available and approximate costs of obtaining retrofit ROPS for tractors:

- University of Kentucky: The Kentucky ROPS Guide”  
<http://warehouse.ca.uky.edu/rops/ropshome.asp>

- NIOSH: <http://www.cdc.gov/niosh/topics/aginjury/crops/>
- Northeast site: <https://www.nycamhoutreach.com/ropstr4u/> (tractor dealers and information regarding self-installation of a commercial ROPS)

The NIOSH Division of Safety Research and Protective Technology Branch has developed a cost-effective rollover protective structures (CROPS) as an alternative to installing commercially available ROPS, which can be hard to find, or as an option for older wheeled agricultural tractors for which ROPS are not commercially available. CROPS have been designed for four tractor models: (1) [Ford 8N](#), (2) [Ford 3000](#), (3) [Ford 4000](#), and (4) [Massey Ferguson 135](#). The NIOSH CROPS for each of the tractor models listed was successfully tested in accordance with Society of Automobile Engineers (SAE) industry standard performance test SAE J2194.

The available designs can be used either by

- an individual to build a NIOSH CROPS for their privately owned tractor
- a company to build and sell a NIOSH CROPS.

Certain parts must be manufactured by a facility that can bend 0.5-inch-thick plate steel (A572-Grade 50). Other parts can be manufactured using a band saw and a drill press. All welded parts must be welded by a professional welder using the appropriate welding procedures for a minimum temperature of -22°F (-30°C) as stated in the SAE J2194 standard. This is an absolute requirement regardless of temperature ranges in the end users local area. **Any deviation from the published designs or the installation of a CROPS on a tractor for which it was not intended will invalidate the performance of the CROPS. In the event of a rollover, operators will not be provided with the level of protection established by SAE J2194.**

Another option for owners of older tractors to obtain information about commercial ROPS retrofits is to contact their local extension office or tractor dealership. ROPS should be certified to meet at a minimum the standards and regulations of various agencies that ensure that the frame or enclosure is designed to provide overturn protection. Professional (dealer) installation assures that the ROPS is properly attached and will not fail under the considerable forces generated in a tractor overturn. Those who choose to self-install a commercial ROPS assume the responsibility and liability for ensuring that the installation has been done properly.

- To alert workers, mark edges of an embankment with visual cues, such as elevated, reflective stakes, orange fencing, or permanent barriers when in a traveled work areas.

A ROPS and seatbelt can only reduce the severity of injury after a tractor has overturned. It is best to prevent the overturn from happening in the first place. The ditch location was not in a

routinely traveled work area on the site, although when vehicles exited the loading area, if a vehicle malfunction or driver error occurred, the vehicle could enter the ditch (See Figure 5). After the incident, the management planned to install concrete highway dividers at the edge of the ditch to prevent a similar incident in the future. In the interim, the company had installed a flexible orange fence at the edge of the ditch. At the time of the MIFACE visit, the fencing had been removed days prior to accommodate the planned installation of the concrete highway dividers (Figure 6).

MIFACE recommends that companies do not remove such visual cues until the day of the installation of permanent barriers.

- Tractor operators should use extreme caution when using tractors on or near sloped terrain, ditches, or embankments.



Figure 5. Embankment edge in relation to loading area.

Tractor overturn incidents can be directly influenced by many factors including the dimensions of the tractor and the dynamics of the tractor's operation with proximity of the tractor to slopes, embankments, rocks, stumps, and etc. The slope and angle of travel of the tractor in relationship to the slope or embankment also influences the stability of the tractor. In order to help prevent an overturn, the operator needs to know how the tractor handles and have a clear understanding of the dynamics of how it responds when driven on different terrain.

There is a delicate relationship between the tractor's characteristics, the type of terrain on which the tractor is driven, how it is driven, and how the operator reacts to his or her environment. Tractor operators need to be aware that most tractors are sensitive to any shift in its center of gravity. Tractor overturn incidents are directly influenced by many factors including: the tractor's dimensions; the position of the tractor's center of gravity; the dynamics of the tractor's operation such as the speed, turning radius, and also the proximity of the tractor to slopes, embankments, ditches, potholes, rocks etc.



Figure 6. Embankment edge marking removed prior to installation of permanent barrier.

The slope and angle of travel that the tractor takes in relationship to the slope also influences the stability of the tractor. These characteristics also change when an implement is attached to the tractor and are influenced by the implement's own design and its position relative to the tractor.

In order to help prevent tractor overturn incidents, the operator needs to understand these relationships so they can make sound judgments on how to maneuver the tractor in different work situations, on different terrain, and in various traffic situations and exposures.

One important thing for safe tractor operation is for the operator to avoid operating the tractor on steep slopes, near ditches, embankments, deep ruts and depressions and holes in the ground. Any or all of these terrain conditions present the strong possibility for initiating tractor overturns.

- Management should develop and implement both a written safety and health program and an employee safety training program that encompasses the written program and safe work practices for their assigned work tasks.

The employer did not have a written health and safety program or a formal employee safety training program. MIFACE encourages all employers to develop such programs to enable them to proactively identify safety and health hazards, prioritize corrective actions, develop and implement safe work practices and promote employee involvement in safety activities.

MIOSHA provides many resources for employers to begin the task of developing and implementing a written safety program. The MIOSHA website has many resource links to assist employers, including a sample written safety and health program. Additionally, employers can contact the MIOSHA Consultation, Education and Training Division (non-enforcement) to come to their site to aid in the development of the facility's written program.

- Install tire chains on two-wheel drive tractors during winter to aid traction.

Tractor tire chains assist in traction when operating equipment in less-than-ideal terrain conditions, such as snow, ice, or mud. Two-wheel drive tractors, like the tractor the decedent was operating, are not particularly good in snow. If the tractor had chains, it would have had better traction and might not have slipped down the embankment. It is important, when selecting chains for a piece of equipment to select chains that are the correct size for the tires to ensure proper fit to receive the desired performance and durability.

**Key Words:** Tractor, ROPS, ditch, slope, fertilizer mixing

## **REFERENCES**

MIOSHA standards cited in this report may be found at and downloaded from the MIOSHA, Michigan Department of Licensing and Regulatory Affairs (LARA) website at: [www.michigan.gov/mioshastandards](http://www.michigan.gov/mioshastandards). MIOSHA standards are available for a fee by writing to:



Michigan Department of Licensing and Regulatory Affairs (LARA), MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan 48909-8143 or calling (517) 322-1845.

- MIOSHA General Industry Safety Standard, Part 22 – Tractors
- NIOSH Workplace Safety and Health Topics – Agricultural Safety: Cost-effective Rollover Protective Structures. <http://www.cdc.gov/niosh/topics/aginjury/crops/>
- University of Kentucky: Kentucky ROPS Guide. <http://warehouse.ca.uky.edu/rops/ropsinstrotherinfo.asp>
- ROPS Retrofit Program (New York, Pennsylvania, Vermont, New Hampshire, Wisconsin) <https://www.nycamhoutreach.com/ropsr4u/>
- MIFACE Investigation Report #05MI089: *Retired Teacher/Farmer Dies When Pinned Under Overturned Tractor*. <http://www.cdc.gov/niosh/face/stateface/mi/05mi089.html>
- Kentucky FACE Investigation Report #95KY047: *Retiree Dies in Tractor Overturn*. <http://www.cdc.gov/niosh/face/stateface/ky/95ky047.html>
- Ayers, Paul. *Tractor Overturn Protection and Prevention*. Cooperative Extension, Colorado State University. Published July 1985. Revised October 1992. NASD online accessed March 17, 2014. <http://nasdonline.org/document/1106/d000892/tractor-overturn-protection-and-prevention.html>
- Washington FACE Investigation Report #99WA056. *Tractor Overturn Kills 16-Year-Old Farm Worker in Washington State*. <http://www.cdc.gov/niosh/face/stateface/wa/99wa056.html>

MIFACE (Michigan Fatality Assessment and Control Evaluation), Michigan State University (MSU) Occupational & Environmental Medicine, 909 Fee Road, 117 West Fee Hall, East Lansing, Michigan 48824-1315; <http://www.oem.msu.edu>. This information is for educational purposes only. This MIFACE report becomes public property upon publication and may be printed verbatim with credit to MSU. Reprinting cannot be used to endorse or advertise a commercial product or company. All rights reserved. MSU is an affirmative-action, equal opportunity employer.

May 1, 2014